The Maryland Agricultural College

QUARTERLY.

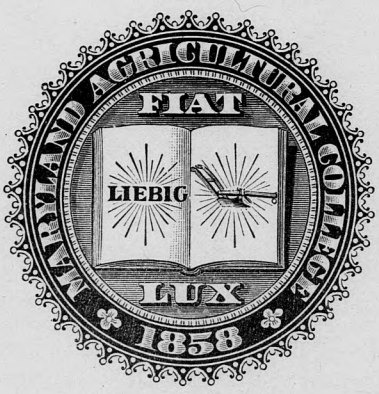
Entered at College Park Post Office as Second-Class Matter.

No. 6. NOVEMBER. 1899.

PUBLISHED BY THE COLLEGE.

R. W. SILVESTER, - - - - - President.

Edited by H. B. McDONNELL, Professor of Chemistry.



Published for the Benefit of Agriculture and Sent Free to Any One Desiring a Copy.

Issued in the Months of February, May, August and November.

Contributions and Correspondence Invited.

ADDRESS

Chemical Department, Maryland Agricultural College,

COLLEGE PARK, MD.

To The Farmers of Maryland.

Read Carefully the Last Page of This Quarterly.

The attention of the farmers is directed to the article in this issue of the "Quarterly" on Seed Testing. It is time that so important a topic should be carefully considered; it is a vital issue to the Agriculturists of the State. The impurities and weaklings among our seeds are responsible for many of our failures to produce crops. The adulteration of the various feeds for domestic animals is an evil against which many of us are contending. It is a losing fight by individuals; some concerted action is necessary. In our April number, it is intended to treat further of this matter. All that we sell is subject to inspection, with charges against our products for this guarantee to purchasers. Are we asking too much when we say that we are entitled to the same protection? We can secure it by a united effort. Will you make it?

Correspondence solicited by the undersigned.

R. W. SILVESTER, President.

College Park, Md.

TESTING SEEDS.

C. O. TOWNSEND.

The object of seed testing should be two-fold: first, to determine what part of the whole quantity of seeds under consideration is capable of germinating and of producing mature plants; second, to show how many seeds of other kinds are present, and what they are. The first is known as the germinative ability and the second as the purity of seeds.

The necessity for procuring good, clean seeds has long been recognized by intelligent farmers and gardeners as an important factor in the production of successful crops, and yet very little effort has been made on the part of planters to obtain thoroughly tested seeds. It is impossible to determine by the general appearance of seeds whether they will or will not sprout. Many failures or partial failures to produce good crops are due very often to a poor stand, caused by the inability of seeds to germinate, or by the presence of worthless plants that over-run and choke out the desired crop. The only satisfactory remedy for this trouble lies in having all seeds to be used in the State, carefully tested. This should be done not only for the protection of the farmers against loss of time, money, and labor, but also as a means of protecting the seed dealer against the false accusation of selling poor seed. No matter how good the condition of the soil may be, nor how favorable the weather, if the seed is poor, the crop will be a failure. It is equally true that no matter how good the seed may be, if the soil is not in proper condition, or the weather is not favorable, the crop will likewise be a failure. If the seeds have been found by careful test to be capable of germinating, the farmer knows at once that the failure is not due to poor seed; hence, it is necessary only to replant from the same stock of seeds when the conditions are more favorable. Or, if it has been found by test that only 50 per cent. of a certain quantity of seeds is capable of sprouting, by planting double the usual quantity a good stand may be insured.

One of the worst enemies with which the farmer is obliged to contend is the weed crop, and one of the most successful means by which weeds are spread is through the agency of impure seeds. We are constantly in receipt of requests for methods of combating weeds. One of the best means is by seeing to it that the seed is what was ordered, and not weed seed. If out of every hundred clover seeds, for example, ten seeds of other plants are found, there is not only danger of seeding the land to weeds, but also the loss of one bushel out of every ten bushels purchased. However, it must be remembered, that

this is not the only means by which weeds are spread; hence, the dealer should not be held responsible for a crop of weeds, unless the seeds sold were impure, and this could be determined only by a careful inspection of the seeds before planting. It is possible for all farmers and gardeners to perform their own tests in determining the germinative ability of seeds, while it is not always an easy matter to determine what impurities are present.

CONDITIONS ESSENTIAL FOR GERMINATION.

In determining the germinative ability of seeds, four conditions must be met, viz: proper degree of heat, proper amount of moisture, sufficient supply of pure air and absence of light.

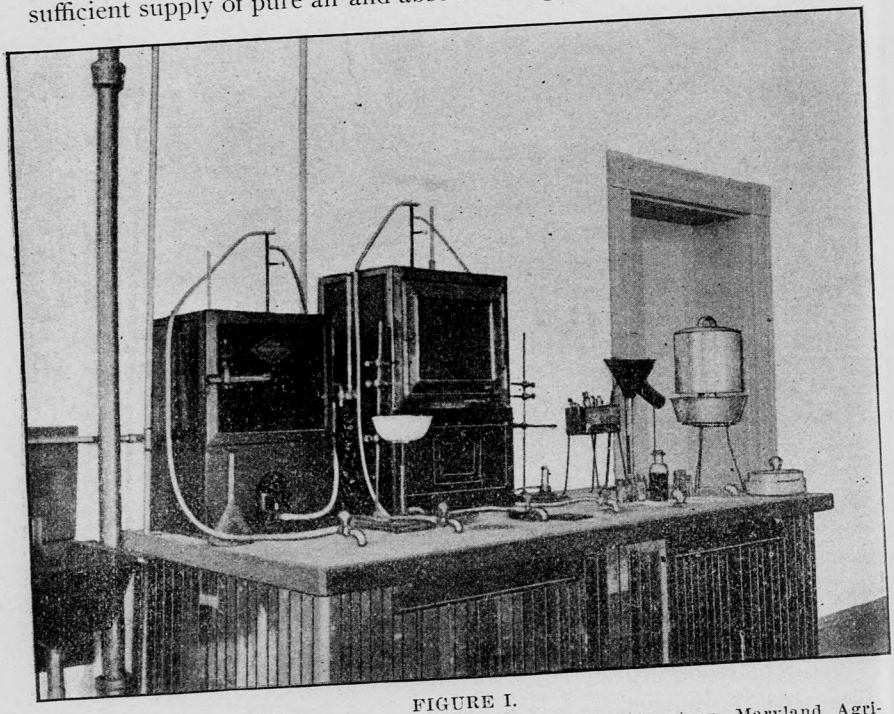


FIGURE I.

Germinating Oven and Sterilizers in the Botanical Laboratory, Maryland Agricultural College.

In regard to the first condition, viz: the degree of heat required for germination, it has been found that different seeds require different degrees of heat for the most rapid and the most complete germination, although the same seeds will germinate more or less perfectly within a wide range of temperature. Wheat, for example, has been known to germinate at all temperatures between 5 degrees and 43 degrees C., or through a range of 38 degrees C., and corn at all tempera-

tures between 98 and 46 degrees C., or through a range of 37 degrees C., and in like manner for other seeds, the range of temperature for germination is more or less extended. However, the most satisfactory temperature for the germination of most seeds lies between 25 degrees and 30 degrees C. (77 degrees to 86 degrees F.), and the farther the temperature is removed from these extremes, the fewer will be the seeds that germinate, or the more slowly germination will proceed. Under normal conditions, however, seeds are required to germinate at about 18 degrees to 20 degrees C, (64 degrees to 68 degrees F.), therefore, they should be tested for germination at this temperature. Since this is practically the temperature of an ordinary living room, it is not difficult to meet this requirement in home testing of seeds. Care should be taken that the temperature does not vary to any marked degree after the tests are started. This is the greatest difficulty in the way of seed testing, but it may be overcome by proper care and forethought. In our seed testing at the Maryland Agricultural College, the seeds are placed in an oven (Fig. 1) and the temperature is regulated automatically in such manner that the variation does not extend through more than 3 degrees.

The second condition to be observed in seed testing, and one equally important with temperature, is the supply of moisture. The practice of soaking seeds for several hours before placing them under the proper conditions for germination is still kept up in some instances, but this preliminary step is unnecessary with most seeds. It is important for a fair test of germinative ability, that seeds remain in contact with some damp substance from which they may absorb the required amount of moisture. It is not sufficient that the seeds be kept in a moist atmosphere—there must be contact with a moist substance. On the other hand, the seeds should not be surrounded, or even partly surrounded by free water. If, during the process of seed testing, it becomes necessary to add a fresh supply of water, care should be taken to have the water at as nearly a normal temperature as possible. Nearly all seeds when brought into contact with a damp substance will absorb moisture and consequently increase in size. This process is purely mechanical and is no evidence that the seeds behaving in this manner are capable of germinating. It is only when the young plant actually breaks through the seed coats that it can be said to have germinated, and the quickness and vigor with which the seedling appears is an indication of the vitality of the seed.

The third condition for successful germination of seeds, is the presence of air. Every seed in the process of germination breathes, i. e., it takes in oxygen and gives out carbonic acid gas; hence, unless the air supply is sufficient to provide the necessary amount of oxygen, germination cannot take place. As a rule it is not necessary to give this condition any special thought in seed testing, since seeds are usually placed under conditions which admit of more or less free circulation of air. One of the objections to covering seeds with water is that it excludes the proper supply of oxygen.

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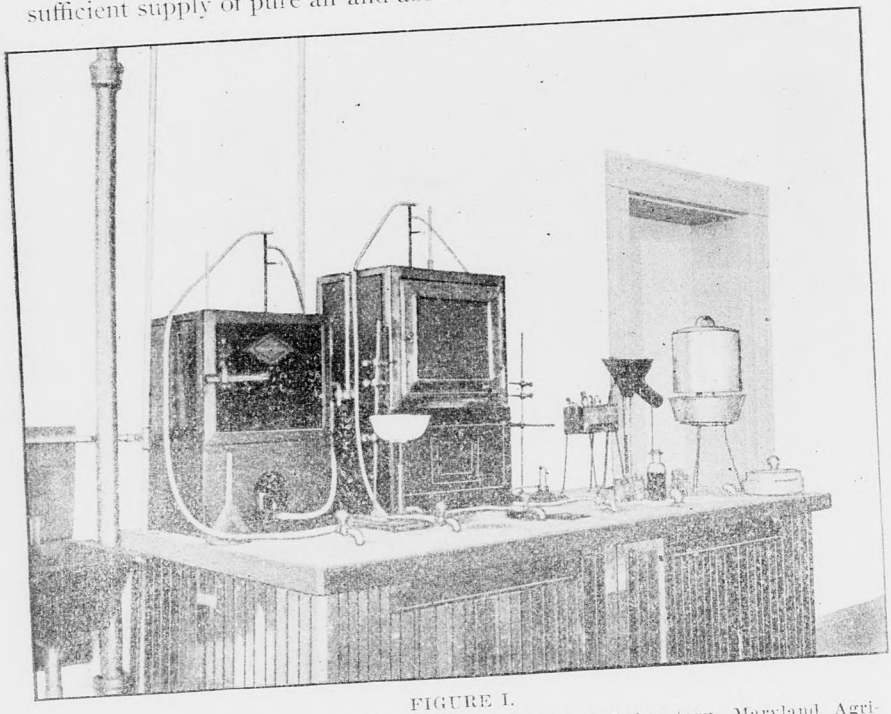

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The fourth condition for the proper germination of seeds is the absence of light. Not only is darkness a normal condition of seed germination, but it has been found that light exerts a marked influence upon some seeds in preventing or hindering their germination. It is a very simple matter to cover the seed in such a manner as to exclude the light. Since it is possible to meet all these conditions with practically no expense and with very little labor, it is within the reach of every farmer and gardener to test his own seeds in regard to their germinative ability, whether the seeds be home grown or whether they be obtained from some other source.

Many simple devices have been used for testing seeds, a few of which will be described here for the benefit of those who may wish to test their seeds at home. The following methods are simply suggestive, since it is necessary only to fulfill the four conditions as nearly as possible, in order to attain the best results.

SEED TESTERS.

One of the simplest forms of apparatus consists of a small box or plant jar, nearly filled with soil, in which a definite number of seeds may be planted, and the whole kept in a room where the temperature

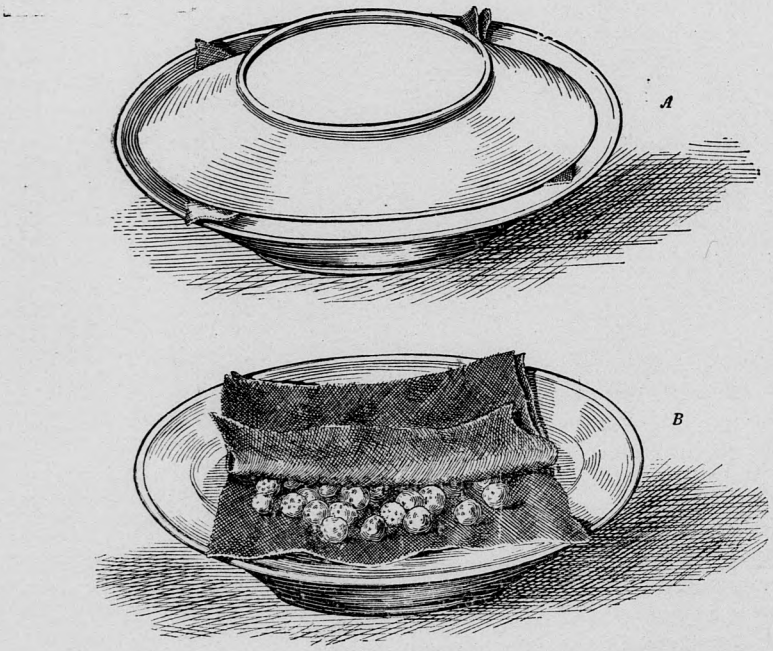

FIGURE II.

Simple Germinating Apparatus. A, closed; B, open. After Pieters. "Testing Seeds at Home." Yearbook U. S. Dept. of Agriculture, 1895. Fig. 23, page 181.

is suitable. After the soil has been placed in the tester, it should be kept in the room until it has attained the proper temperature before planting the seeds. The soil should be sufficiently moist, and to prevent too rapid evaporation, the box or jar may be covered with glass or with a board after planting. If the soil in the field or garden is warm enough and there is not too much variation in temperature between day and night, the test may be performed out of doors. If these or similar methods are used, it is necessary to wait until the young plants come up, when they may be counted and compared with the total number of seeds planted.

Another very simple and easily prepared device is shown in Figure II, consisting of two plates and two pieces of white flannel cloth, each of which is nearly as large as one of the plates.

The cloths should be soaked in water of proper temperature and then wrung out, leaving them very damp. One of the cloths should now be spread upon one of the plates and upon this cloth a definite number of the seeds to be tested should be placed. These should be covered with the second cloth, and over the whole the second plate should be turned as shown in Figure II A. The second plate shuts out

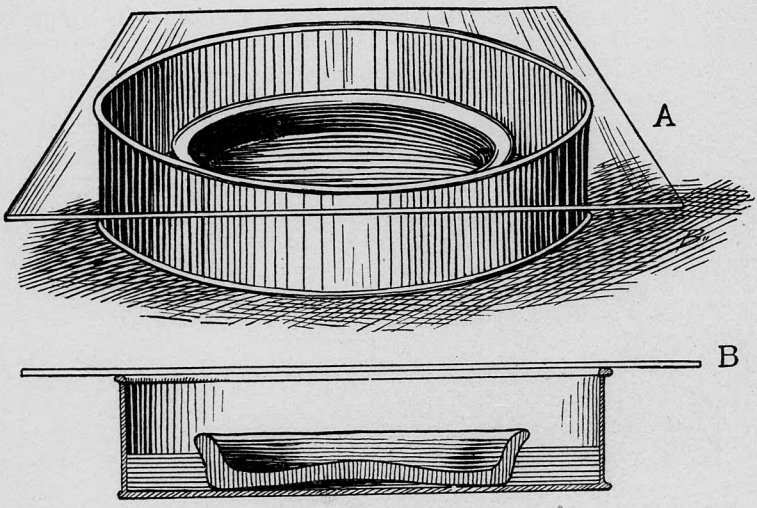

FIGURE III.

Home-made Germinating Apparatus, A, complete; B, section. After Pieters. "Testing Seeds at Home. Yearbook U. S. Dept. of Agriculture, 1895. Fig. 24, page 182.

the light and prevents evaporation without preventing circulation of air. This apparatus may be opened from time to time, and the seeds that have begun to sprout may be removed and the number recorded. When it becomes apparent that no further germination will take place, the total number of seeds that have sprouted may be compared with the original number placed in the tester and the percentage of germination

thus determined. For example, if 160 seeds were placed in the tester and 120 sprouted, the percentage of germination would be 120 divided by 160, which equals .75 or 75 per cent.

Figure 3 shows a very satisfactory tester which may be made for home use. It consists of an unglazed earthen saucer, placed in a tin basin, or other dish containing a little water, and the whole covered with a board to exclude light and to prevent evaporation. If a tin basin is used for the outer dish, it should be painted within to prevent rusting. The seeds to be tested may be placed directly in the porous saucers, through which enough water will soak to cause the seeds to germinate. This apparatus may be improved by placing folds of blotting paper or flannel cloth in the porous saucer and placing the seeds between the folds as described in the year book for 1894, page 405. If the water evaporates from the outer dish in spite of the covering, it is necessary only to add a fresh supply from time to time, in order to keep the level of the water nearly as high as the top of the porous dish. If this apparatus is kept at suitable temperature it will give very satisfactory results. The percentage of germination may be determined as in the preceding case.

Sometimes it is desirable to test several varieties of seeds at the same time. An apparatus for this purpose, as shown in Figure IV, will be found convenient. This apparatus is composed of a metal frame which is made to rest at its four corners on four supports, and the whole is placed in a large square pan, partly filled with water. If the frame and the pan are composed of iron, they should be painted to prevent rusting. Folds of damp cloth or of blotting paper should be

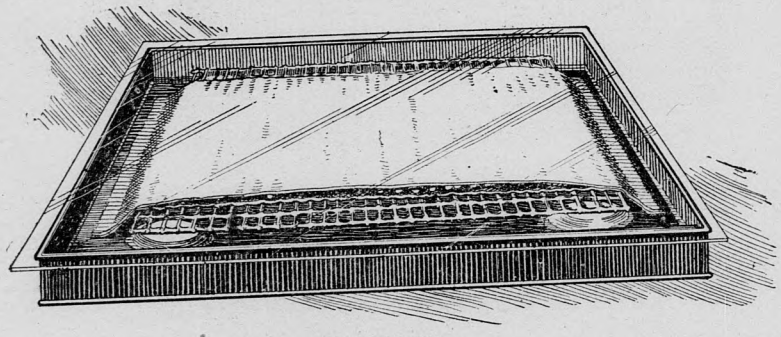

FIGURE IV.

Apparatus for germinating several varieties at one time. After Pieters. "Testing Seeds at Home." Yearbook U. S. Dept. of Agriculture, 1895. Figure 25, page 183.

spread over the frame and the seeds to be tested should be spread between the folds. At each end of the frame, a flap of cloth or paper should be allowed to fall down into the water; this will enable the water to be drawn up by capillary attraction, thus supplying the seeds with sufficient moisture to produce germination. As evaporation takes place, a fresh supply of water should be added from time to time, exces-

sive evaporation being prevented by covering the pan as in the preceding cases. In all these forms of apparatus the covers fit closely enough to allow sufficiently free circulation of air.

These are only a few of the many forms of simple seed testing that are now in use, and it is probable that the ingenuity of many farmers and seed dealers will enable them to devise other forms equally as good or even more suitable for their special needs. In our own work in seed testing at the Maryland Agricultural College, we use among others, the so-called Geneva Seed Tester, devised by the New York Experiment Station. This consists of a strip of flannel cloth about nine inches wide, hemmed on each side and then doubled over in folds about two inches wide. The folds are sewed across near the top, and in the loops thus formed, small brass rods, ten inches long, are passed. The whole is now moistened with water and placed in a zinc pan of rectangular form and of proper size, so that the ends of the rods rest on the edges of the pan. The cloth is thus suspended in the pan which contains a small amount of water, but not enough to come into contact with the folds. The seeds are placed in these folds and are kept moist by capillary attraction through the ends of the cloth which dip into the water in the bottom of the pan. The whole is covered with a pane of glass and placed in the incubator (the larger oven shown in Fig. I). This is a very convenient form, as it admits of a ready examination of the seeds, and enables one to test a large number of samples at the same time. It may be used without the incubator by keeping it in a room where the temperature is normal and practically constant. The incubator, however, fulfills the four necessary conditions almost perfectly, since in addition to the constant temperature maintained by an automatic regulator and the sufficient supply of moisture, it is perfectly dark within, when closed, and at the same time permits a free circulation of air. It is probable that any seeds that will not germinate in this apparatus would not germinate under any normal conditions.

In using any of these forms of apparatus in which cloth or paper are used, it is well to boil the cloth or paper occasionally and to scald the rest of the apparatus, for the prevention of mold, which might develop and interfere with the germination of the seeds. The number of seeds and the date should be written on a piece of paper and placed in or under the apparatus for comparison at the end of the test.

TIME REQUIRED FOR GERMINATION.

The length of time required for germination differs with different seeds, and even seeds in the same sample and under the same conditions, often require different periods of time for germination. This may be due to the inability of the water to enter the seed through the seed coats, or it may be due to external conditions, or to a difference in the vigor of seeds. As a rule, the difference in the time of germination of seeds is a test of their vigor, those of the highest degree of vigor germinating first. Some seeds will germinate within a single day, while

others (notably the stone fruits) require forty-five days or even longer. Seeds that germinate readily should be examined at intervals of twenty-four hours, in order to note whether they have a high or low degree of germinative energy. Ten days is usually considered a sufficient length of time for most seeds to germinate, although the seeds of pines, oaks, beeches, alders, some grasses, beets, carrots and others require a longer time.

SELECTING SAMPLES.

The aim in selecting a sample of seeds for testing, should be to obtain in as small a bulk as possible, some of all the kinds and grades of seeds in the whole quantity and in the proportion in which they actually occur. Samples should not be taken by picking out the seeds one by one, since this almost invariably results in the selection of too high a percentage of those seeds that are the largest, and apparently the best. If the quantity of seed is small, as well as the individual seeds, the sample may be selected by pouring the seeds from one vessel to another, and from this stream catching a small quantity of the seeds at short intervals in a spoon or other small vessel. If the quantity of seeds to be tested is large, samples should be dipped from different parts of the whole bulk, and the final sample selected from these samples after they are thoroughly mixed. When the final sample has been selected, the number of seeds should be counted and recorded as previously directed. If the individual seeds are large, the sample tested should consist of from fifty to one hundred seeds, while if the individual seeds are small, the sample should consist of from one hundred to four hundred seeds.

PERCENTAGE OF GERMINATION.

It is not to be supposed that all the seeds in any given quantity will germinate. Failure to germinate arises from the fact that some seeds do not mature, or that they sooner or later lose their germinative energy. The number of such seeds in any sample will depend upon the kind of seed, conditions of growth, method of gathering, age of seeds, etc. The following table will show the percentage of germinable seeds that may reasonably be expected in some of the common plants. Most samples will probably vary slightly from these numbers, but any marked decrease in the percentage of germination, would indicate that the seeds are of poor quality.

TABLE OF GERMINATION STANDARDS.

Name of Seed.	Perc't'ge of Germination.	Name of Seed.	Perc't'ge of Germination.
Beans, bush	95	Melon, musk	92
Beans, Lima	95	Melon, water	92
Buckwheat	92	Onion	85
Cabbage	95	Oats	95
Celery	65	Peas	98
Clover, red	90	Pumpkin	92
Clover, scarlet	90	Radish	95
Corn, field	95	Salsify	83
Corn, sweet	92	Spinach	89
Cucumber	92	Squash, winter	92
Cauliflower	85	Squash, summer	92
Grass, orchard	80	Tomato	90
Grass, timothy	90	Tobacco	88
Eggplant	85	Turnip	95
Lettuce	90	Wheat	95

This table is made up in part from a similar table given on page 184, Yearbook for 1895.

PURITY OF SEEDS.

Of more importance frequently than the germinative ability of seeds is the absence of the seeds of noxious weeds. Weed seeds are often overlooked, especially if they are of the same general size and color as the seeds with which they are mixed. And even if seen, they are often neglected by farmers and gardeners because of the fact that weed seeds are usually few in number and the nature of the weed is not recognized by its seed. It is important that the nature of weeds represented by their seeds should be known, since it is often better to refuse to plant seeds of doubtful quality than to run the risk of introducing troublesome weeds. In some instances, it is comparatively easy to separate weed seeds from the desired seed, while in other cases it is not practicable. All farmers and gardeners should exercise the greatest care in planting pure seeds only, regardless of the source from which they are obtained. The percentage of purity is determined by dividing the number of good seeds by the total number of seeds in the sample. Having found the percentage of germination and the percentage of purity of any sample, the real value of the seed is determined by multiplying the two percentages together and dividing by one hundred * e. g.; if the percentage of germination is 90, and the percentage of purity is 98, the real value is 90 multiplied by 98 divided by 100, equals 88.2 per cent.

To show the importance in dollars and cents of purchasing seeds of a high percentage value, suppose we purchase twenty bushels of seed for $30.00, or $1.50 per bushel, and we find that the seed shows a real

*Circular No. 18. U. S. Department of Agriculture, Division of Botany.

value of only 75 per cent. This means that one bushel out of every four, or five bushels out of every twenty, are worthless or worse than worthless; then we have paid $30.00 or $2.00 per bushel for fifteen bushels of good seed and have five bushels of trash thrown in. On the other hand, if our twenty bushels of seed shows by fair test a real value of 95 per cent., we have nineteen bushels of good seed and only one bushel of worthless material. In this case the good seed actually cost $1.58 per bushel, and the risk of seeding our farms with noxious weeds is only one-fifth as great as in the preceding case.

It is important both to the seed dealer and to the planter that the real value of the seeds be known before they are planted, or even before they are placed on the market. This information may be obtained by performing the tests above mentioned, or if desired, samples of seeds may be addressed to the Botanical Department of the Maryland Agricultural College, College Park, Md., where they will be tested free of charge as far as our limited facilities permit.

QUESTIONS AND ANSWERS.

I. N. S.—I am a butcher and farmer and would like some information as to how I can best save the blood for fertilizing purposes.

Could the blood be poured on some dry ground under a shed, with some plaster or perhaps kainit?

Also, could I compost the balance of the offall so that it would not be offensive and gradually dissolve it so it could be incorporated with rock and kainit?

A.—You will be able to save some of the blood by absorbing it with dry earth so that it will be available for immediate use at home, but a satisfactory commercial product cannot be made in this way; plaster, and especially kainit cannot be used to advantage to absorb it.

You will hardly be able to compost the offall so that it will not be offensive. The best way is to steam everything containing grease and press out the grease, then dry the residue and the blood. It is then easily ground and in the proper condition to be mixed with phosphate and potash. In some cases it is convenient to use the exhaust steam to furnish the heat for drying. Manufacturers of fertilizer machinery make machines for this purpose.

R. C.—Please explain the advantages of a fertilizer containing nitrogen, as there is a firm now selling fertilizer here, and they have nitrogen in all their analyses and claim it more valuable than ammonia, but have both guaranteed on the bags.

A.—"Nitrogen" is another way of stating the "Ammonia," except that 14 lbs. of nitrogen will make, or is equal to 17 lbs. of ammonia. The nitrogen is all included in the guarantee of ammonia and it is not necessary to give both. Ammonia is not often put into fertilizers as ammonia, or as an ammonium compound, but as some material (as dried blood, tankage, etc.) containing nitrogen; this nitrogen may form ammonia. In some places the nitrogen is guaranteed instead of ammonia.

S. H.—I have bought some tankage and find that it contains glass; have I not been cheated?

A.—Tankage, junk bones, etc., frequently contain glass, old nails, scrap iron and miscellaneous foreign matter. This is not added in order to adulterate, but gets in during the storing and handling of the material. This kind of foreign matter is easily detected by inspection, and is rarely present in sufficient amount to have any material difference in the composition. It is objectionable on account of its liability to injure the grinding machinery of the mills, clogging the drills, etc.

J. B., H. R. and others.—What is the meaning of the chemical term K_2O, used in analyzing fertilizers? Also the difference between Sulfate of Potash and Actual Potash? I notice the Sulfate is always used in much larger figures than the "Actual" is. Please give the commercial figures as to value on both the Sulfate and Actual, as related to Potash and also Ammonia.

(Note.—We have taken the liberty to change our correspondent's spelling of "Sulfate" to conform to the latest usage of chemists.)

K_2O is the chemical formula for actual potash, or potash; it is the oxide of potassium. K is the symbol for potassium and O for oxygen; the figure 2 after the K means that two chemical equivalents of potassium are combined with one of oxygen. This is only a chemical curiosity in the free or pure state and, for fertilizing purposes at least, it is always used when combined with some acid, as muriatic acid with which it forms muriate of potash, or with sulphuric acid as sulfate of potash; the chemical formula of the latter is K_2SO_4, sometimes written $K_2O.SO_3$, indicating the fact that we have in the compound sulfur and oxygen combined with the potash.

Pure sulfate of potash contains 54 per cent. of potash, but the pure article is too expensive to be used for fertilizing purposes. The high grade for fertilizing purposes contains from 48 to 50 per cent. potash; the commercial muriate of potash contains about 54 per cent. of potash often spoken of by fertilizer men as "actual potash," because sometimes they try to mislead the purchaser by pretending that sulfate of potash is "potash" when it is only about half potash. They usually just double the figures for potash to give the sulfate of potash. Potash as the sulfate is better adapted to some crops than other forms of potash. It costs a little more—about half a cent a pound more for potash in that form at the present time K_2O about 4.5 cts. per lb. in muriate and 5 cts. in sulfate).

Sulfate of ammonia is only one-fourth, or 25 per cent., ammonia; 17 parts of ammonia are equivalent to 14 parts of nitrogen.

Sulfate of ammonia is worth three cents per pound, hence, ammonia is worth four times as much, or twelve cents per pound.

J. R.—Will bone and lime act well when put on same crop?

A.—Yes; there is no incompatibility between raw bone and lime, and they may be mixed before applying them, if it is more convenient that way. With dissolved bone, or any soluble phosphate, however, the case is different; the lime precipitates the soluble phosphoric acid before it has a chance to diffuse throughout the soil. If it is desired to apply both lime and a soluble phosphate to the same crop, the lime should follow the ploughing and be well harrowed in before the fertilizer is applied; the fertilizer may then be applied by the drill in the usual way or applied broadcast before the last harrowing.

J. B. M.—I am a farmer and would like to know where to buy my fertilizer. Who makes the best fertilizer?

A.—You will find the names and addresses of all manufacturers of fertilizers, doing business in this State, in our January and August numbers, together with analyses of their fertilizers. Make your own selection, having due regard, of course, to the prices quoted you by

these manufacturers or their agents. For obvious reasons we cannot recommend any particular brand or firm. Do not be influenced too much by an occasional analysis below guarantee, or an occasional one decidedly above guarantee; this may be accidental. But if any particular make of fertilizer is found to be habitually below the guarantee it is well to avoid that firm's fertilizers.

Do not buy the "cheapest" fertilizer without regard to composition. If you need potash or ammonia, or both in your fertilizer, you should not think of a less amount than one per cent. of each.

J. H.—Is Phosphoric Acid from S. C. Rock as good as that from Bone?

A.—Yes, when dissolved they are practically the same. This statement refers to the phos. acid alone. Dissolved bone contains nitrogenous matter ("ammonia") in addition to the available phos. acid.

A ton of dissolved S. C. Rock mixed with about 600 lbs. of good tankage or dried fish, or 450 lbs. of dried blood is worth as much, as a fertilizer, as a ton of good dissolved bone.

A. D.—I sent you a sample of fertilizer for analysis two months ago. Why have I not heard from you?

A.—We frequently get samples with nothing attached whereby they may be identified—not even the postmark. Often the senders do not even write that they have sent a sample. Of course such samples do not receive attention. Your sample may be one of these. Never send samples without first sending to us for the proper blanks and instructions. We handle thousands of samples and have a regular system for doing it, and if this system is followed by those who wish to avail themselves of the privilege of sending samples, there will be no trouble about the identity of the samples.

F. M.—I have some fertilizer that I would like to have analyzed for my own satisfaction, but do not want a report sent to the manufacturer, as I do not intend to make any fuss about it if it is not up to the guarantee. Can this be done?

A.—We cannot agree to keep any secrets of this kind; everything that goes on our books is public property. All analyses of regular brands are published, and before being published a report is sent to the manufacturer, so that if he claims that there is an error the claim may be investigated before the result is published. We rarely publish the results of the analysis of "made to order" mixtures, because they are not of general interest. However, we do not hide the results should any one inquire about them.

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